



Comparative study of the effect of three chemical insecticides on oil palm pollinating insects

Assiènin Hauverset N'guessan^{1*}, Kouamé Jean-Noël Konan², Ahou Cyprienne Kouassi³, Kouassi Allou⁴, Sékou Diabate⁵

¹ National Centre of Agronomic Research – La Mé, Laboratory of Entomology; 13 BP 989 Abidjan 13, Côte d'Ivoire

² National Centre of Agronomic Research – La Mé, Genetic Improvement Laboratory; 13 BP 989 Abidjan 13, Côte d'Ivoire

³ Félix Houphouët-Boigny University, Laboratory of Natural Environments and Biodiversity Conservation, 22 BP 582 Abidjan 22, Côte d'Ivoire

⁴ National Centre of Agronomic Research – Marc Delorme, Laboratory of plant pathology, Port-Bouët, Côte d'Ivoire, 07 BP 13 Abidjan 07, Côte d'Ivoire

⁵ National Centre of Agronomic Research – Robert Michaux, Central Laboratory of Biotechnology, 01 BP 1740 Abidjan 01, Côte D'Ivoire

Abstract

Oil palm is an important cash crop in Côte d'Ivoire. This plant harbors many insects, including pollinators that actively participate in its production. However, the populations of these insects are often destroyed by man through the chemical treatments. This work aimed to conduct a comparative study of the effect of three chemical insecticides on oil palm pollinating insects. The insecticides Evisect-S 50, Sivanto Energy 85 EC and Proteus 170 O-TEQ, were mixed respectively with 25 g/10 L of water and 25 ml/10 L of water to make the slurries used for the different treatments. The results revealed the presence of pollinating insects in all treatments. Therefore, all of the chemicals tested were harmful to pollinating insects for the first three days after application. However, Evisect-S 50 caused more deaths during these three days. From day 7 to day 14 the effect of these insecticides was lessened. Therefore, these chemicals do not have a significant long-term effect on oil palm pollinating insects. Nevertheless, it would be necessary to assess the effect of other chemicals as well as the impact of certain natural enemies on pollinating insects.

Keywords: pollinating insects, oil palm; inflorescences, chemical insecticides

1. Introduction

Oil palm is a crop that has developed in Côte d'Ivoire thanks to the policy of crop diversification decided upon since independence in 1960. Today, this crop occupies an important place in the Ivorian economy. It allows Côte d'Ivoire to be the first producer in West African Monetary Economic Union (WAEMU) level with 90 % of the total volume of palm oil produced (Osseni *et al.*, 2009; Tuo, 2013) and the 2nd African producer behind Nigeria (Tuo, 2013) [16]. Moreover, in Côte d'Ivoire, palm oil ranks 4th place after cocoa, coffee and cotton (Ballo et Kouamé, 2000) [2]. The sector has a turnover of just over 500 billion CFA francs and provides a living for 2 million people with 200,000 regular jobs in Côte d'Ivoire (Anonymous, 2015) [1]. However, the important position of oil palm among cash crops is largely due to pollinating insects, whose presence induces a good fruit set and high production. Among these insects are species of the genus *Elaeidobius* (Coleoptera: Curculionidae), the genus *Microporum* (Coleoptera: Nitidulidae), the genus *Atheta* (Coleoptera: Staphylinidae), etc. (Hala *et al.*, 2012; N'Guessan *et al.*, 2020) [6, 12]. Furthermore, oil palm pollinating insects are often subject to massive attacks by predators but especially by the use of certain chemicals by man during treatments against certain pests such as *Coelaenomenodera lameensis* (Coleoptera: Chrysomelidae - Hispinae), the main pest of oil palm. This can have a negative impact on the activity of oil palm

pollinating insects and therefore on oil palm production. The objective of this work is to conduct a comparative study of the effect of three chemical insecticides on oil palm pollinating insects.

2. Materials and methods

2.1 Study Site

The work was carried out at the research station of the National Centre of Agronomic Research (CNRA) of La Mé. This station is located at 5° 26' North, 3° 50' East and at an altitude of 23 meter. It is located in the south-east of Côte d'Ivoire, in the Lagoon region, and is bordered to the east by the Mé River and to the south by the Aghien lagoon. It is located 30 kilometer north-east of Abidjan, on the road leading to Alépé.

2.2 Sampling method

The tests were conducted at the CNRA station in La Mé. The device used was a completely randomized device (DCA). Four oil palm plots E70, I73, E60, F20 aged 7 to 9 years were selected for this trial. Four blocks of thirty (30) trees each were selected from each plot. These three blocks were chosen separately so that one treatment would not be influenced by another due to wind. The trees in the different blocks were then labelled. Each block corresponds to one treatment. Thus, the different treatments are recorded in Table 1 below.

Table 1: Insecticides used in the test

Treatments	Active ingredients	Doses tested
Témoins non traité	-	-
Evisect S-50	Thiocyclan hydrogen oxalate	25 ml/10 L water
Sivanto Energy 85 EC	- Deltamethrin (10 g/l) - Flupyradifurone (75 g/l)	25 g /10 L water
Proteus 170 O-TEQ	- Thiacloprid (150 g/l) - Deltamethrin (20 g/l)	25 ml/10 L water

These are normal treatments carried out against oil palm leaf pests. However, the target is pollinating insects. These are species of the genus *Elaeidobius*, *Microporum*, *Atheta* etc. that abundantly frequent the male and female flowers of oil palm.

2.3 Assessment of Pollinating Insect Population Size

Before treatment, samples were taken from the different study plots on selected trees in each block whose inflorescences were in full anthesis. Five (5) male spikelets were collected from each inflorescence. The insects on the spikelets were immobilized with a spray of 0.25% Transfluthrin and 0.20% Permethrin. These various samples were sent to the laboratory where the inflorescences were stripped to count the pollinating insects. Treatments were carried out with a 25 ml slurry per 10 L of water for Sivanto Energy 85 EC and Proteus 170 O-TEQ respectively, followed by 25 g per 10 L of water for Evisect-S 50. Spraying was done using a sprayer. After treatment, male spikelets were collected at 4 a.m. on day 1, day 3, day 7 and day 14 in these plots to count the pollinating insects present.

2.4 Data Analysis

All data were subjected to an analysis of variance using the General Linear Model (GLM) procedure in SAS software version 9.4, after checking the normality of the data with the Levene test at the 5% threshold. The comparison of means was performed using the Waller-Duncan test at the 5% threshold.

3. Results

3.1 Number of pollinating insect populations

Before treatment

Before the various chemical treatments, samples taken showed that the mean numbers of pollinating insects were 5525.8 pollinating insects for the untreated control, 5434.4 pollinating insects for Sivanto Energy 85 EC, 4736.2 pollinating insects for Proteus 170 O-TEQ and 5421.9 pollinating insects for Evisect 50 S. The analysis of variance did not show a significant difference ($p = 0.82$) between these population numbers for the different treatments. They were thus the same in all treatments (Table 2).

Table 2: Average numbers of pollinating insects before different chemical applications

Treatments	Average population numbers
Témoins non traité	5525,8 ± 619,30 ^a
Sivanto Energy 85 EC	5434,4 ± 760,91 ^a
Proteus 170 O-TEQ	4736,2 ± 823,80 ^a
Evisect 50 S	5421,9 ± 435,42 ^a
P	0,82

Means with the same letter in the same column are not significantly different at the 5% threshold (Waller-Duncan T-test).

After treatment

Four hours (4 h) after treatment, the average number of populations recorded was 5,645 pollinating insects at the

level of the untreated control. These population numbers were 2,657 insects with the Evisect-S 50. They were average for the Sivanto 85 EC and the Proteus 170 O-TEQ with 4,164 and 3,167 pollinating insects, respectively. Thus, the analysis of variance showed significant differences ($P = 0.008$) between these treatments with regard to the numbers of populations of pollinating insects (Table 3).

One (1) day after treatment, the average number of populations sampled was 3486.50 and 3065 pollinating insects respectively in the untreated control and in the Sivanto Energy 85 EC. However, these average numbers obtained with the Proteus 170 O-TEQ were 2,401 pollinating insects and 1,962.80 pollinating insects with the Evisect-S 50. These average numbers observed between these treatments are statistically different ($P = 0.04$) (Table 3).

On the 3rd day after treatment, the average number of populations taken from the untreated control was 1085.30 pollinating insects and 1109.80 pollinating insects with Sivanto Energy 85 EC. However, 893.80 pollinating insects were collected with the Proteus 170 O-TEQ and 742.50 pollinating insects with the Evisect-S 50. All these values are statistically different ($P = 0.03$) (Table 3).

On the 7th day, these populations were 36, 40.75, 50.25 and 45.50 pollinating insects respectively in the untreated control, Sivanto Energy 85 EC, Proteus 170 O-TEQ and Evisect-S 50. No statistical difference ($P = 0.86$) was observed between these treatments with regard to populations of pollinating insects (Table 3).

In the 14th after the treatments, the pollinating insect samples gave an average number of populations of 24 pollinating insects at the level of the untreated control. At the Sivanto Energy 85 EC level, an average number of 19.75 pollinating insects was obtained. At the Proteus 170 O-TEQ, an average number of 23 pollinating insects was collected. Finally, at the level of the Evisect-S 50, an average population size of 31 pollinating insects was obtained. No significant difference ($P = 0.93$) was also revealed between the treatments with regard to the average number of populations of insect pollinators of oil palm, on day 14 (Table 3).

3.2 Average population numbers according to the observation periods

Generally, the average population size was 3,907.90 pollinating insects before the various chemical applications. At 4 hours and 1 day after the treatments, the average numbers of populations observed were identical, respectively of 2917.80 and 2723.90 pollinating insects. At 3 days after treatment, the average population size of these insects was 957.30 pollinating insects. However, at 7 days and 14 days after treatment, the average numbers of populations observed were 43.10 and 24.40 pollinating insects, respectively. These population numbers are statistically different ($P = 0.0001$) with regard to the observation periods (Table 4)

Table 3: Monitoring of the average number of pollinating insect populations

Treatments	Sampling periods				
	4 h	Day 1	Day 3	Day 7	Day 14
	Average population numbers				
Untreated control	5645 ± 1193,12 ^a	3468,50 ± 861,33 ^a	1085,30 ± 500,49 ^a	36,00 ± 5,55 ^a	24,00 ± 13,46 ^a
Sivanto Energy 85 EC	4164 ± 989,39 ^{ab}	3065,30 ± 647,39 ^a	1109,8 ± 455,88 ^a	40,75 ± 6,33 ^a	19,75 ± 9,94 ^a
Proteus 170 O-TEQ	3167 ± 288,44 ^{ab}	2401,00 ± 551,97 ^b	893,8 ± 381,91 ^b	50,25 ± 15,53 ^a	23,00 ± 7,52 ^a
Evisect-S 50	2657 ± 428,29 ^b	1962,80 ± 725,74 ^b	742,5 ± 451,87 ^b	45,50 ± 16,81 ^a	31,00 ± 17,24 ^a
p	0,008	0,04	0,03	0,86	0,93

Les moyennes avec la même lettre dans une même colonne ne sont pas très significativement différentes au seuil de 5 % (Waller-Duncan T-test).

Table 4: Average population numbers according to sampling periods

Sampling periods		Average numbers of pollinating insects' populations
Before treatment 0 hour		3907,90 ± 760,91 ^a
After treatment	4 hours	2917,80 ± 420,64 ^b
	Day 1	2723,90 ± 431,11 ^b
	Day 3	957,30 ± 375,56 ^c
	Day 7	43,10 ± 31,35 ^d
	Day 14	24,40 ± 13,46 ^d
P		0,0001

Means with the same letter in the same column are not significantly different at the 5% threshold (Waller-Duncan T-test).

4. Discussion

During this study, the main pollinating insects of the oil palm were encountered on our test plots. Among others, those are, *Elaeidobius kamerunicus*, *Elaeidobius plagiatus*, *Elaeidobius subvittatus*, *Elaeidobius singularis*, *Elaeidobius bilineatus*, Coleoptera Curculionidae. The beetle species Nitidulidae *Microprum congolense*, *Microporum dispar*, and the beetle Staphilinidae *Atheta burgeoni* were also encountered there. According to Desmier de Chenon (1981)^[5] and Mariau and Genty (1988)^[10], in Côte d'Ivoire, almost twenty (20) species of insects are subservient to the inflorescences of the oil palm. Also, Kouakou *et al.* (2018)^[8] reported that seventeen species of pollinating insects frequent the male and female inflorescences of the oil palm, explaining the presence of many pollinating insects on the study plots. Furthermore, before the treatments, pollinating insect populations were statistically identical at the level of all treatments. This invariability in population size could be explained by the fact that the different test plots are subjected to the same environmental and climatic conditions. Therefore, there would be no ecological or physical barriers that could lead to variations in the populations of these insects in these plots. These results corroborate those of Cock *et al.* (2011)^[4], who state that the physiological level of tolerance of some insects to extreme events leading them to colonize a new area is low.

The results obtained indicate a significant difference between the different treatments at 4 hours, 1 day and 3 days after the chemical applications with regard to the numbers of pollinator populations. Indeed, the number of populations has greatly decreased in the treated plots compared to the untreated control. These results are consistent with those of Louveaux (1985)^[9]. According to

him, precise and eloquent statistics are available in certain countries such as the United States where it is cited the destruction of 70,000 colonies of bees in California, in the year 1967 alone, due to treatments of cotton with carbaryl. These useful insects would not be protected during chemical applications and would therefore be affected by these treatment products. Similarly, the works of Tasei (1996)^[15] has shown that naturally, the use of insecticides is a factor that sometimes seriously disturbs pollinating insects, because they are insufficiently protected despite their status as agricultural auxiliaries and their beneficial action in maintaining the diversity of spontaneous flora. During the three successive observation periods of 4 h, 1 day and 3 days after treatment, the number of pollinating insect populations was significantly reduced by Evisect-S 50 compared to Sivanto Energy 85 EC and Proteus 170 OTQ. This reduction in the pollinating insect population by this insecticide would be due to the toxins contained in this chemical.

Indeed, the Evisect-S is a selective insecticide acting by contact and by ingestion then, having a shock action, thus killing the affected insects. Philippe (1990)^[14] has shown that Evisect has a paralyzing effect and directly blocks the ganglia of the central nervous system of the animal by masking the receptors of neurons. This has resulted in the sharp decline in the populations of insects pollinated by this insecticide in this study. The results also show that no significant difference was observed between treatments with respect to the numbers of pollinator populations on days 7 and 14. All treatments had no effect on pollinating insects at these periods. This inefficiency could be explained by the fact that these products specially sprayed in the oil palm foliage did not have direct contact with oil palm pollinating insects. In this sense, Philippe (1990) indicated that the spray treatment of Evisect-S 50 is not harmful to pollinating insects which maintain their populations at a practically normal level since the decrease in insect numbers is only temporary. Brittain *et al* (2010)^[3] also confirmed this hypothesis in a landscape-scale study of wild bees. According to them, the insecticide fenitrothion does not show a negative effect on bumble bees as the flight capabilities of these species may allow them to reach less treated habitats.

During this study, the population numbers varied generally from around 3908 pollinating insects before treatments to around 25 pollinating insects on the 14th day after treatment. These variations would be due to chemical treatments on the one hand; on the other hand, this decrease could be linked to the senescence of the inflorescences of the oil palm in the study plots. In fact, the chemicals used led to a reduction in the number of populations during the first three observation periods from 2,917.80 to 957.30 pollinating insects compared to the untreated control (3,907.90 pollinating insects).

Our results are in agreement with those of Nabti (2015)^[11] who indicated that the chemical substances applied on crops contaminate bees through nectar, pollen, but also air, water and soil. They can be toxic to bees in the short term or, at low doses, can cause chronic effects that weaken or even kill bees. In addition, on days 7 and 14 the numbers of pollinating insects were very low, 43.10 and 24.40 pollinating insects. Jacquemart (2011)^[7] showed that oil palm pollen has a lifespan of 5 days. The death of pollen due to fading of the inflorescence would therefore be the

cause of the low level of pollinating insects at these observation periods in this study.

5. Conclusion

All species of oil palm pollinating insects in Côte d'Ivoire were collected from the trials. Also, all chemicals tested were found to be harmful to pollinating insects during the first three sampling periods after application. Evisect-S 50 caused more deaths during these three days. However, from day 7 to day 14 their effect was lessened because these insects would have a high reproduction rate which would have allowed them to duplicate their populations to reach the same level of populations as the untreated control. Therefore, these chemicals had no significant long-term effect on oil palm pollinating insects. Nevertheless, it would be necessary to evaluate the effect of other chemicals as well as the impact of certain natural enemies on pollinating insects.

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